FACGSE

A Spaceport Facility and GSE Acquisition Cost Estimator

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FACGSE Documentation Notes
A SPACEPORT FACILITY AND GSE BASELINE COST ESTIMATOR

This spreadsheet uses Shuttle historical cost information on the acquisition of facilities and ground support equipment (GSE) to assist in estimating these costs for new vehicles.

This historical cost information has been used to derive “CER’s” or Cost Estimating Relationships.

These CER’s are simple in that they require only the geometric information on a new concept, such as size of the vehicle, stacked dimensions, and payload space dimensions.

The estimates for facility and GSE acquisition costs for a new concept CAN NOT be used “as is” because of this prior simplification. Rather, the estimates are a starting point for further modification and adjustment based on other factors. These factors include technology, improvements in design or operations, reliability, design life, and so forth.

A model such as AATe (Architectural Assessment Tool - enhanced) may be used to perform these adjustments.

As another enhancement, this spreadsheet has been created to avoid having to estimate certain required inputs, such as the needed size of a mobile launcher platform, without which some calculations are not possible (launch pad, integration).

Explanation and Documentation on Each Spaceport Module Calculation

Costs Included and Not Included

Any cost generated is a total cost, including design and engineering, and the acquisition.

There is insufficient documentation to determine if the historical cost information includes other costs such as:

- Activation.
- Facility and GSE Development costs, for originating and validating any facility and GSE challenges.
- Associated but indirect costs such as civil service labor, engineers, and oversight of contracts.

- Values generated are likely optimistic (less than the actual costs incurred).

- Spares are calculated and included as a spares factor of 6.5% applied only to GSE, but may be changed by going into the workings of the FACGSE spreadsheet.

Explanation and Documentation on Each Spaceport Module Calculation

Estimation of Costs for New RLV Facilities and GSE

- **Duplicating an existing design:**
  - The cost to duplicate an existing facility or module function given existing design and engineering may be roughly 1/4 to 1/2 the cost of the first unit. As an example, the cost to build a new turnaround facility for Shuttle, exactly duplicating an existing design, is much less than predicted by historical information because of the savings from sunk design and engineering costs. These would not be re-incurred.

- **Inflation:**
  - The prior factor roughly counters any “10 year doubling” of costs due to inflation (bringing costs back to the original, but still costly amounts).

- **New estimates include design and engineering:**
  - Because the calculations by CER are indirectly a measure “given equal complexity as Shuttle facilities and GSE, and accounting only for size differences” any new estimates include the impact of design and engineering.

- **Further Cost Modifiers Required:**
  - Further modification of the prior “estimates” for an RLV are required for a valid sense of costs. These factors would adjust for technology, improvements in design or operations, reliability, design life, and so forth.
  - The AATe Model can perform this function of modifying cost estimates for these factors.

- **Sunk costs can not be discounted for a new RLV:**
  - A new RLV can not discount estimates due to sunk design and engineering costs. A new RLV will incur these costs as facilities and GSE depart in specifics from Shuttle equivalents.

1-Payload / Cargo Processing

Use COMET/OCM ***VPF*** (Payload / Vertical Processing Facility) values.

CofF=19.4*10^6/(217*71*105) =11.99
GSE=39.96/19.4 =2.06

C of F Equation Space Factors

202, 56, 45

Required STS Inputs

217-202 =15
71-56 =15
105-45 =60

NOTES:

This is the payload bay dimension as inputs.

This indicates that the cost of a vertical payload processing facility is roughly $60M dollars in unadjusted year 1987 dollars (a sum of 19.4+39.96). A rough doubling for decadal inflation would take the value to ~ $120M dollars in year 2001 dollars.

2-Traffic Flight Control

Use COMET/OCM LCC-FR (Launch Control Center, Firing Room) values.

CofF=2.75*10^6/(120*90*15)	=16.98
GSE=37.48/2.75	=13.63

C of F Equation Space Factors

Use purely room dimensions.

Required STS Inputs

=120
=90
=15

NOTES:

This value must be modified by AATe to estimate forward to new concepts.

This indicates that the cost for a new launch control center / firing room would be roughly $40M dollars in unadjusted year 1987 dollars (a sum of 2.75+37.48). A rough doubling for decadal inflation would take the value to $80M dollars in year 2001 dollars.

This estimation CER is likely very conservative given approximate costs for 2 new Mission Control rooms at JSC of about $250M and costs of also about $250M dollars for 3 new launch control rooms at KSC both in late 1990'ish dollars (a very rough, optimistic CER of $200M per single string set of traffic control capability).

A new RLV estimate would require adjustment of any value so as to generate an estimate accounting for improvements due to vehicle design technology, computing, advances, etc.

3-Launch … Part 1 of 2

Use COMET/OCM RSS (Rotating Service Structure) values (plus FSS ahead).

CoF=307.75*10^6/(390*325*265)
GSE=437/307.75

C of F Equation Space Factors

230, 190, 81

Required STS Inputs

390-230	=160
325-190	=135
265-81	=184

NOTES:

This is the most expensive of facilities and GSE - roughly $750M dollars in unadjusted year 1987 dollars (a sum of 307.75+437). A rough doubling for decadal inflation would take this value to **$1.5 Billion dollars** in year 2001 dollars.

These input values derive from the length and width respectively of the mobile launcher platform (160’ by 135’) and the height of the stack from the MLP level up (184’).

For a new concept, assuming an integrate-transfer-launch scenario requiring an MLP type facility, the 2 required MLP dimensions are derived ahead in “Integration” impacts.

This way, deriving MLP dimensions ahead from vehicle dimensions provided by the user, eliminates the need for the user to estimate (offline) any required MLP dimensions. Only vehicle dimensions are required.

3-Launch … Part 2 of 2

Use COMET/OCM FSS (Fixed Service Structure) values (plus RSS prior).

CoF=264.3*10^6/(390*325*402)
GSE=375.3/264.3

C of F Equation Space Factors

230, 190, 218

Required STS Inputs

390-230	=160
325-190	=135
402-218	=184

NOTES:

This is the most expensive of facilities and GSE - roughly $640M dollars in unadjusted year 1987 dollars (a sum of 264.3+375.3). A rough doubling for decadal inflation would take this value to **$1.3 Billion dollars** in year 2001 dollars.

These input values derive from the length and width respectively of the mobile launcher platform (160’ by 135’) and the height of the stack from the MLP level up (184’).

For a new concept, assuming an integrate-transfer-launch scenario requiring an MLP type facility, the 2 required MLP dimensions are derived ahead in “Integration” impacts

This way, deriving MLP dimensions ahead from vehicle dimensions provided by the user, eliminates the need for the user to estimate (offline) any required MLP dimensions. Only vehicle dimensions are required.

4-Landing / Recovery

Use COMET/OCM offline estimate as indicated by Mike Nix at MSFC.

CoF=$5 per cubic foot concrete
GSE factor of 1

NOTES:

Any adjustment here is required by such a tool as AATe or by a user recognizing if the concept in question needs a landing runway at all.

5-Turnaround

Use COMET/OCM OPF (Orbiter Processing Facility) values.

CoF=28190000/(197*150*95)
GSE=173.94/28.19

C of F Equation Space Factors

75, 72, 38

Required STS Inputs

197-75	=122
150-72	=78
95-38	=57

NOTES:

A single RLV element (like an orbiter) length, width and height are required for this CER.

This indicates that the cost of a turnaround facility and GSE is roughly $200M dollars in unadjusted year 1987 dollars (a sum of 28.1+173.94). A rough doubling for decadal inflation would take this value to ~ $400M dollars in year 2001 dollars.

Space factors account for necessary space adjacent to the vehicle dimensions allowing as complex a vehicle as a Shuttle orbiter to be processed.

6-Integration/Assembly … Part 1 of 2

Use COMET/OCM VAB (Vehicle Assembly Building) values.

CoF=124.72*10^6/(280*240*525)
GSE=71.09/124.72

C of F Equation Space Factors

120, 105, 376

Required STS Inputs

280-120	=160
240-105	=135
525-376	=149

NOTES:

These input values derive from the length and width respectively of the mobile launcher platform (160’ by 135’) and the height of the stack from the MLP level up (184’).

For a new concept, assuming an integrate-transfer-launch scenario requiring an MLP type facility, the 2 required MLP dimensions are derived ahead in “Integration” impacts

This way, deriving MLP dimensions ahead from vehicle dimensions provided by the user, eliminates the need for the user to estimate (offline) any required MLP dimensions. Only vehicle dimensions are required.

****The last value of 149’ is here substituted in calculations for the RLV height I.e. would require STS as 184’.***

6-Integration/Assembly … Part 2 of 2

Use COMET/OCM MLP (Mobile Launcher Platform) values.

First, a “scalable” or “rubber” MLP is calculated based on proportions of the vehicle stacked length, width and height.

Second, these L and W values are provided to the previous RSS and FSS (launch) calculations and to the integration facility calculation (previous, Part 1).

Lastly, the actual MLP costs are calculated as follows:

CoF=98.06*10^6/(160*135*47)	=96.59
GSE=70.61/98.06	=0.72

NOTES:

Using vehicle dimensions the derived or “rubber” MLP dimension is derived. These MLP dimensions are used to estimate the costs of the new MLP on a volumetric basis using the CofF and GSE factors derived above.

This indicates that the cost of an MLP was roughly $170M dollars in unadjusted year 1987 dollars (a sum of 98.06 and 70.61). A rough doubling for decadal inflation would take the value to ~ $340M in year 2001 dollars.

Offline estimates for new MLP’s for the Shuttle program, which would be duplicates of existing, without having to reproduce the original design and engineering, have floated at about $164M dollars which roughly coincides with the CER estimate if the halving factor for reduced or eliminated design and engineering is considered.

7-Vehicle Depot Maintenance
8-Spaceport Support Infrastructure
9-Concept Unique Logistics
10-Transportation System Operations Planning and Management

Expert judgement is used here to derive the indirect FACGSE spaceport module costs. A factor of 25% or a "wrap" is applied to the previous "in-line" (payload, traffic, launch, landing, turnaround, integration, expendables) sums.

11-Expendable element

This CER is not used in this FACGSE spreadsheet intended for RLV's.

Original COMET/OCM Facility and GSE Estimation Interface

VEHICLE: Rocket, ACRE 92 SSTO BNA

DATA INPUTS

VEHICLE DESCRIPTION	ELEMENT DIMENSIONS (FT) L	W	H
Element 1: Rocket, ACRE 92 SSTO BNA	157.30	87.00	42.00
Element 2:			
Element 3:			
Element 4:			
Element 5:			

FACILITY REQUIREMENTS

DB NUM	FACILITY NAME	REQ'D ? (1=Y)	ELE PROC	NUM FACIL	ELE DIMENSIONS (FT) L	W	H
1	icle Depot Maintenance Facilities	1	1	1	157.3	87	42
2							
3	Expendable Element Faciities						
4	Vehicle Turnaround Facilities	1	1	2	157.3	87	42
5	Payload/Cargo Processing Fa	1	1	2	30	15	15
6							
7	le Assembly/Integration Facilities						
8							
9							
10							
11							
12							
13							
14							
15							
16	oncept-Unique Logistics Facilities	1	1	1	0	0	0

COST REDUCTION FACTORS

	FACILITY NAME	COST REDUCTION FACTORS C of F	GSE	SPARES	REDUCTION DESCRIP
1	icle Depot Maintenance Facilities				
2	-				
3	Expendable Element Faciities				
4	Vehicle Turnaround Facilities				
5	/load/Cargo Processing Facilities				
6	-				
7	le Assembly/Integration Facilities				
8	-				
9	-				
10	-				
11	-				
12	-				
13	-				
14	-				
15	-				
16	oncept-Unique Logistics Facilities				

COST OUTPUT

	FACILITY NAME	C of F	GSE	INIT SPARES	TOTAL OST/FACI	TOTAL COST
1	le Depot Maintenance Facilities	$24.9	$23.7	$1.5	**$50.1**	**$50.1**
2	-	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
3	Expendable Element Faciities	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
4	Vehicle Turnaround Facilities	$43.9	$271.0	$17.6	**$332.5**	**$665.1**
5	oad/Cargo Processing Facilities	$17.5	$36.1	$2.3	**$56.0**	**$112.1**
6	-	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
7	Assembly/Integration Facilities	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
8	-	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
9	-	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
10	-	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
11	-	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
12	-	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
13	-	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
14	-	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
15	-	$0.0	$0.0	$0.0	**$0.0**	**$0.0**
16	oncept-Unique Logistics Facilities	$21.6	$0.0	$0.0	**$21.6**	**$21.6**
	TOTALS	**$107.9**	**$330.8**	**$21.5**	**$460.3**	**$848.8**

DATABASE

ESCALATION 87$ to 97$: 1.48

INITIAL SPARES FACTOR (%*GSE): 6.50%

	FACILITY NAME	ACTUAL BASIS	C of F M87$/F^3	GSE FACT	DIMENSION FACTORS L	W	H
1	le Depot Maintenance Facilities	RPSF	$3.15	0.95	190	80	50
2	-	SRBDF	$21.77	0.17	101	93	47
3	Expendable Element Faciities	ET Cell	$7.77	0.80	53	62	27
4	Vehicle Turnaround Facilities	OPF	$10.04	6.17	75	72	38
5	oad/Cargo Processing Facilities	VPF	$11.99	2.06	202	56	45
6	-	SSMEPF	$7.47	0.63	64	37	46
7	Assembly/Integration Facilities	VAB	$3.54	0.57	120	105	376
8	-	MLP	$96.59	0.72	74	57	137
9	-	MLP+LUT	$11.96	0.88	74	57	262
10	-	LP+FSS	$5.19	1.42	230	190	218
11	-	LP+MSS	$5.72	1.42	230	190	218
12	-	LP+RSS	$9.16	1.42	230	190	81
13	-	LCC-FR	$16.98	13.63	120	90	15
14	-	SRBDF	$4.69	1.13	101	93	47
15	-	LRBDF	$4.41	1.12	101	93	47
16	oncept-Unique Logistics Facilities	MISC	25.0%	0.00	0	0	0

	14	-	SRBDF	$4.69	1.13	101	93	47
	15	-	LRBDF	$4.41	1.12	101	93	47
	16	anding/Recovery Facilities	Runway	$5.00	0.57	17000	300	1.5
	17	-	OTHER					
:s	18	-	MISC	25.0%	0.00	0	0	0

1-Payload facility/GSE calculation requires payload bay like dimensions to use these space factors

2-Traffic LCC like FR dimensions

3-Launch RSS and FSS calculation requires MLP L and W and stack height like dimensions as input

4-Landing needs L, W and height (thickness) of runway as input

5-Turnaround uses orbiter type L, W and H dimensions.

6-Integration / Assembly …NOTE: the last space factor given that the values of 120 and 105 yield MLP values but the last yields 149 (an SRB height).

FACGSE

New FACGSE Interface

(Step 1) ENTER ALL DIMENSIONS IN FEET (X')

Set to STS Defaults

		INPUTS (Green)	
Length Vehicle (end of engine to nose) >	Lv	122	
Width Vehicle (usually same as wingspan) >	Wv	78.06	
Hieght Vehicle (standing on landing gear) >	Hv	56.67	
Length, Stacked >	Ls	76.6	< Length here may be apx. Hieght vehicle
Width, Stacked (may be wingspan)>	Ws	78.06	
Hieght, Vehicle (long dimension) >	Hs	184	< Hieght here may be Length vehicle
Length, Payload (may be diameter)>	Lp	15	
Width, Payload (may be diameter)>	Wp	15	
Hieght, Payload (longest dimension)>	Hp	60	

(Step 2) ENTER CONCEPT NAME → STS Settings

OUTPUTS - FACGSE ACQUISITION COSTS

View Baseline Data for Use in AATe Database

Concept Name>	STS Settings			
	FA $M	GSE $M	Sparing	Total Cost
PAYLOAD / CARGO PROCESSING	$ 29	$ 59	$ 4	$ 92
TRAFFIC / FLIGHT CONTROL	$ 4	$ 55	$ 4	$ 63
LAUNCH	$ 847	$ 1,202	$ 78	$ 2,127
LP+RSS	$ 455	$ 647	$ 42	$ 1,144
LP+FSS	$ 391	$ 555	$ 36	$ 983
LANDING / RECOVERY	$ 57	$ 57	$ 4	$ 117
VEHICLE TURNAROUND	$ 42	$ 257	$ 17	$ 315
VEHICLE ASSEMBLY / INTEGRATION	$ 342	$ 217	$ 14	$ 573
Integration Cell Type (VAB derived)	$ 197	$ 112	$ 7	$ 316
MLP Derived	$ 145	$ 105	$ 7	$ 256
VEHICLE DEPOT MAINTENANCE	$ 330	$ 462	$ 30	$ 822
SPACEPORT SUPPORT INFRASTRUCT.	$ 330	$ 462	$ 30	$ 822
CONCEPT UNIQUE LOGISTICS	$ 330	$ 462	$ 30	$ 822
TRANS.SYS. OPS PLAN. & MANGMNT.	$ 330	$ 462	$ 30	$ 822
EXPENDABLE ELEMENT	$ -	$ -	$ -	$ -
COMMUNITY INFRASTRUCTURE	$ -	$ -	$ -	$ -
0	$ 2,639	$ 3,694	$ 240	$ 6,573
	$ 6,573			

STS MLP is 165' by 135' by 47', Derived MLP is > 160 135 47

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